An Evolutionary Algorithm Based Approach for Business Process Multi-Criteria Optimization

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ABSTRACT

Business processes design optimization is known as the problem of creating feasible business processes while optimizing their criteria such as resource cost and execution time. In this paper, the authors propose an evolutionary multi-criteria approach based on a modified evolutionary algorithm for generating optimized business processes. The main contribution of this work is a framework capable of (i) generating business processes using an enhanced version of evolutionary algorithm NSGAII, (ii) verifying the feasibility of each business process created employing an effective algorithm, and (iii) selecting Pareto optimal solutions in a multi criteria optimization environment up to three criteria, with use of an effectual fitness function. The experimental results showed that the authors’ proposal generates efficient business processes with high quality in terms of qualitative parameters compared with existing solutions.

KEYWORDS
Business Process, Design Optimization, Evolutionary Computing, Multi-Criteria Optimization, NSGAII

INTRODUCTION

The good management of a company requires the knowledge, the understanding and the best possible alignment of business processes with the company objectives. The management of these processes is known as the Business Process Management (BPM), and its interest is now well recognized by all companies (Hammer & Champy, 1993). One of the main steps of BPM is the Business Process Optimization (BPO) and with a view to be cost-effectively successful, an increasingly number of companies relies on BPO for improved performance, better efficiency and greater productivity. With its focus on process efficiency, companies are making business processes more flexible, faster and better integrated in the overall company strategy.

A business process (BP) has multiple definitions (Dahman, 2012; Porter, 2012). Hammer and Champy (1993) testified that “A business process is a set of activities that takes one or more kinds of input and creates an output that has value to the customer”. According to Davenport (1993) “A
business process is a structured set of activities designed to produce a specific output”. Salomie et al. (2012) defined the business processes multi criteria optimization (BPMCO) as follows.

\[ P = (BPS, F, C) \]

with \( BPS \) is the search space of business processes \( (sol \in BPS) \), \( F \) is the Fitness function that assigns a numerical score \( F(sol) \) for each BP in the search space, \( C \) is a set of constraints. The aim of the optimization problem is to find either the instance of global optimal BP \( sol_{opt} \), such as

\[ \forall sol \in BPS, F(sol_{opt}) < F(sol) \]

or a near-optimal BP \( sol_{nopt} \) such that

\[ F(sol_{opt}) - F(sol_{nopt}) < \delta. \]

This work presents a new and original approach for the generation of feasible business processes instances based on a business process model in a true multi-criteria optimization environment up to three optimization criteria. The generation of business processes instances will be handled by an enhanced evolutionary algorithm (Mahammed & Benslimane, 2016), while checking the feasibility of these instances will be ensured using an efficient algorithm. To do so, this approach focuses on the use of a activities-based-business-process i.e., business process tasks for the modeling, because of the abundance of works using it in the literature (Johanson et al., 1993; Soliman, 1998; Volkner and Werners, 2000; Dayal et al., 2001; Stock and Lambert, 2001; Gunasekaran and Kobu, 2002; Castellanos et al., 2004; Havey, 2005; Weske, 2010; Tiwari & al., 2010a; Schumm et al., 2011; Smirnov et al., 2012; Dumas et al., 2013; Laguna and Marklund, 2013). In addition to the activities, we decided to use their attributes (e.g., cost of resources, execution time and customer satisfaction), while neglecting other characteristic components of BPs, for the evaluation of the solutions. Salomie et al. (2012) noted that business processes optimization is a difficult issue because of the nonlinear nature, and often discontinuous mathematical models involved. For its part, Tiwari et al. (2010a) asserted there is relatively little work for BPMCO with a fixed design and optimizing the participating tasks. The contributions of this work are threefold. First, the verification of the feasibility of generated BPs is provided by the Reverse Process Verification Algorithm (ReProVA). Second, this work uses an adapted and enhanced evolutionary algorithm (xNSGAII) for the generation of those BPs. Third, the optimization criteria used in the multi criteria optimization of those BPs are three: cost resources, execution time and customer satisfaction.

The breakdown of this paper is as follows. Section 2 presents a state of the art on the BPMCO with evolutionary computing. Section 3 presents an exhaustive description of the proposed business process multi-criteria optimization approach, and explain (i) the quantitative representation used to represent the business processes, (ii) the algorithm proposed for the verification of the solutions and (iii) the enhanced evolutionary algorithm suggested for finding solutions to the problem. Section 4 introduces a real life test scenario, evaluates and discusses obtained experimental results. Finally, section 5 summarizes our research and provides future work directions.

RELATED WORK

A precision should be announced for the numerous works presented in the following; business process modeling languages are legion (Mili et al., 2010), as BPMN and used in numerous areas, even the least expected such as security in the cloud by simulating the daily operations in a data center (Chang & Ramachandran, 2016). As and despite this fact the works cited are -in large part- limited to represent a process as an acyclic weighted graph. This ascertainment may be argued by the simplicity to move from design to implementation, and only a few can claim to be able to optimize business processes (Farsani et al., 2013).

(Hofacker & Vetschera, 2001) are considered to be the first to really have worked on BPMCO with an evolutionary algorithm, a genetic algorithm in this case. However, their work had not achieved satisfactory results. The model developed was rather complicated due to limitations in mathematical
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